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DE3412590 A WPI Abstract Accession No.
97-219543/20 & J09064957 A

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(54) **Terminal equipment and call connection method for a wireless local loop**

(57) A wireless local loop (WLL) terminal equipment 200 connects a standard telephone 201 to the PSTN by radio link via a cellular radio system 250-253 such as a GSM system. The terminal equipment comprises a baseband part 210 and RF part 240 forming an RF transceiver for communication with base station 251, and a line adaptor 230 forming an interface with the telephone 201. A single processor 211 controls both the line adaptor and RF transceiver thus reducing cost and complexity of the circuitry. A method of outgoing call connection from telephone 201 comprises monitoring the sequence of digits dialled. After the selection of each digit the time elapsed is counted and the sequence is compared with previously dialled numbers stored in memory. If the sequence corresponds to a previously dialled number then it is sent as a connection code to the base station. If the time elapsed reaches a set limit the sequence is sent. The sequence is stored in memory only if the connection is successful. Previously dialled numbers are stored in a prioritised list.

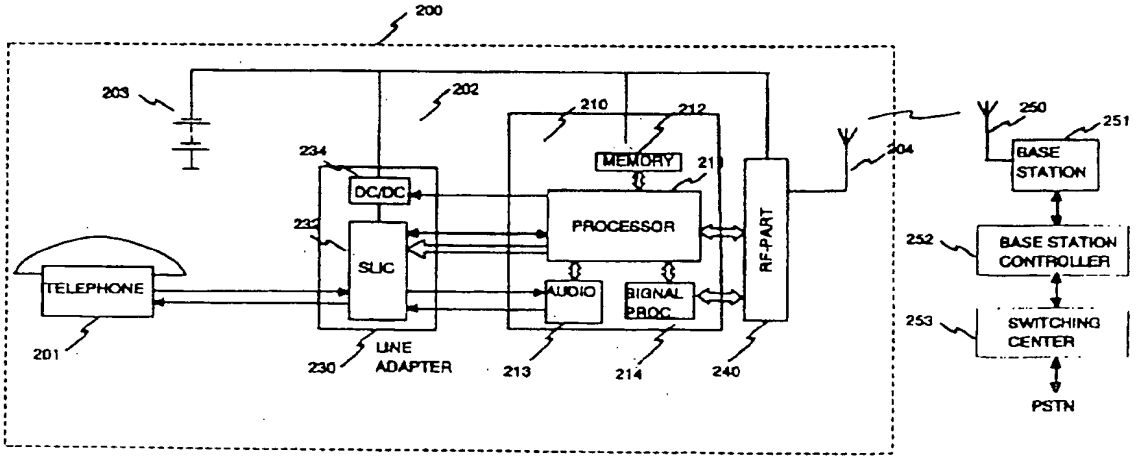

FIG. 2

GB 2 311 696 A

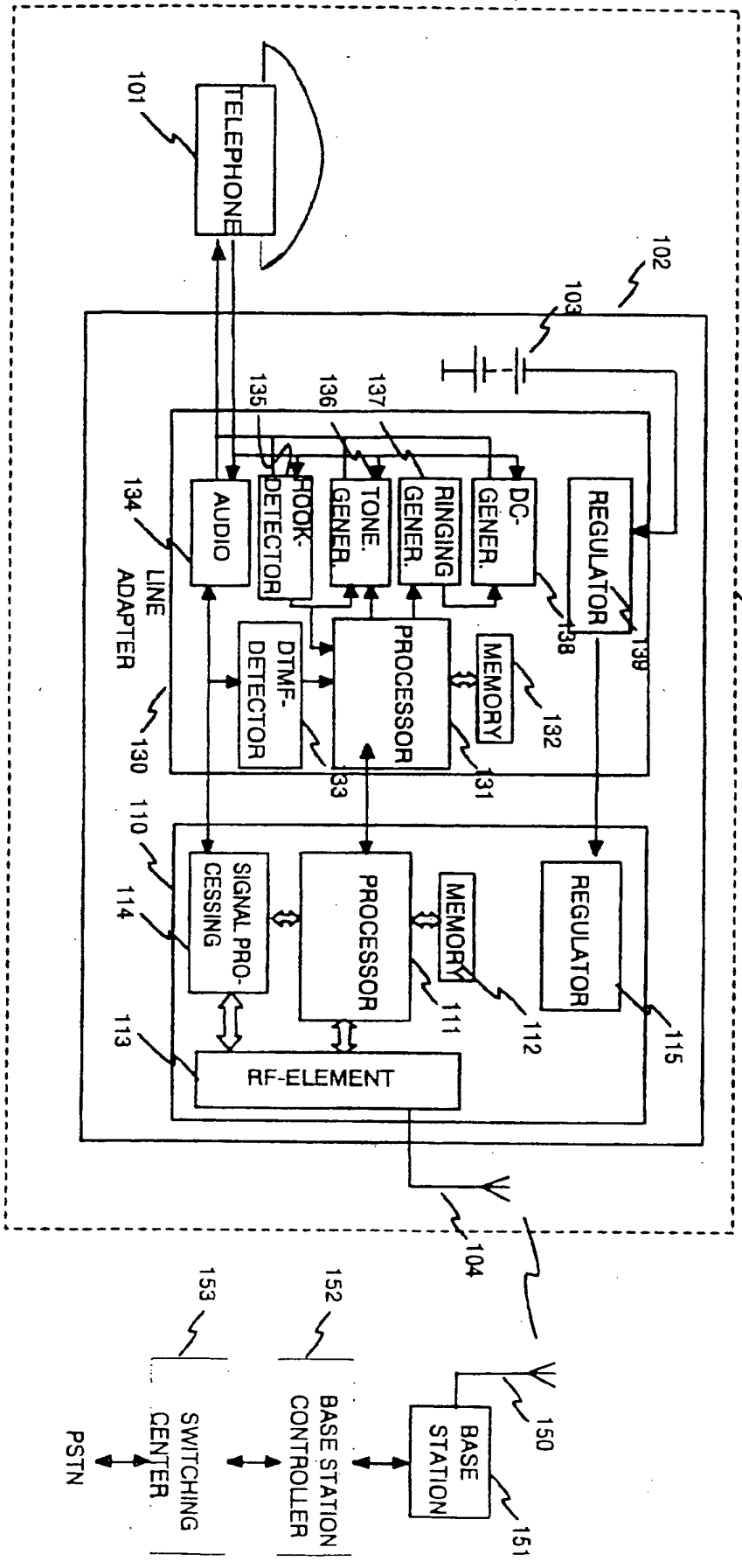
TELEPHONE
101
102
103
100
135
136
137
AUDIO
HOOK-DETECTOR
TONE GENER.
RINGING GENER.
DC-GENER.
REGULATOR
134
LINE ADAPTER
130
DTMF-DETECTOR
PROCESSOR
MEMORY
132
131
133
138
139
110
SIGNAL PRO-CESSING
114
PROCESSOR
MEMORY
111
112
REGULATOR
115
113
RF-ELEMENT
104
150
BASE STATION
151
152
BASE STATION CONTROLLER
153
SWITCHING CENTER
PSTN

FIG. 1

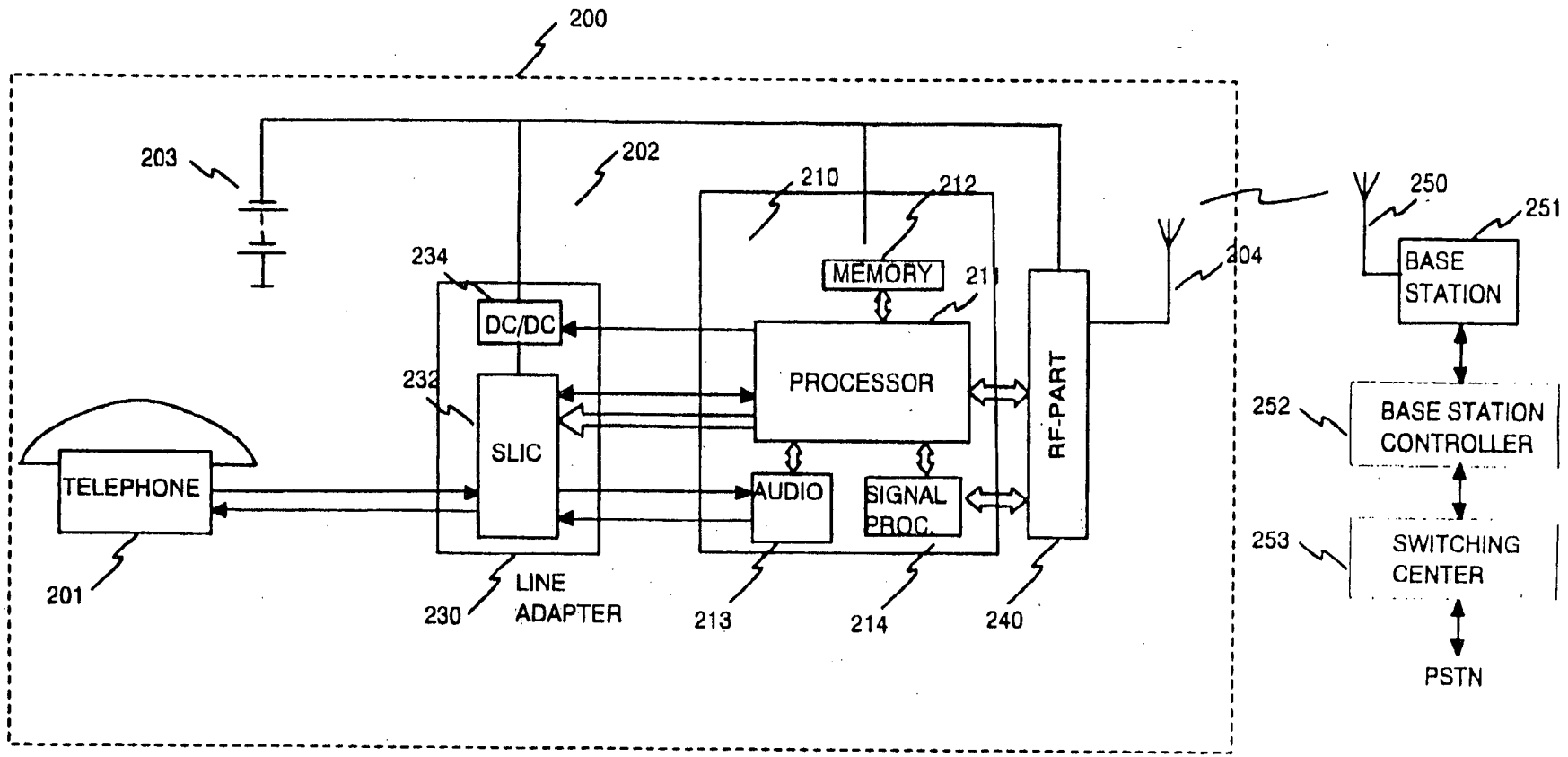
200
203
202
210
212
250
251
234
MEMORY
211
204
DC/DC
BASE STATION
232
PROCESSOR
RF-PART
SLIC
252
BASE STATION CONTROLLER
TELEPHONE
AUDIO
SIGNAL PROC.
253
SWITCHING CENTER
201
230
LINE ADAPTER
213
214
240
PSTN

FIG. 2

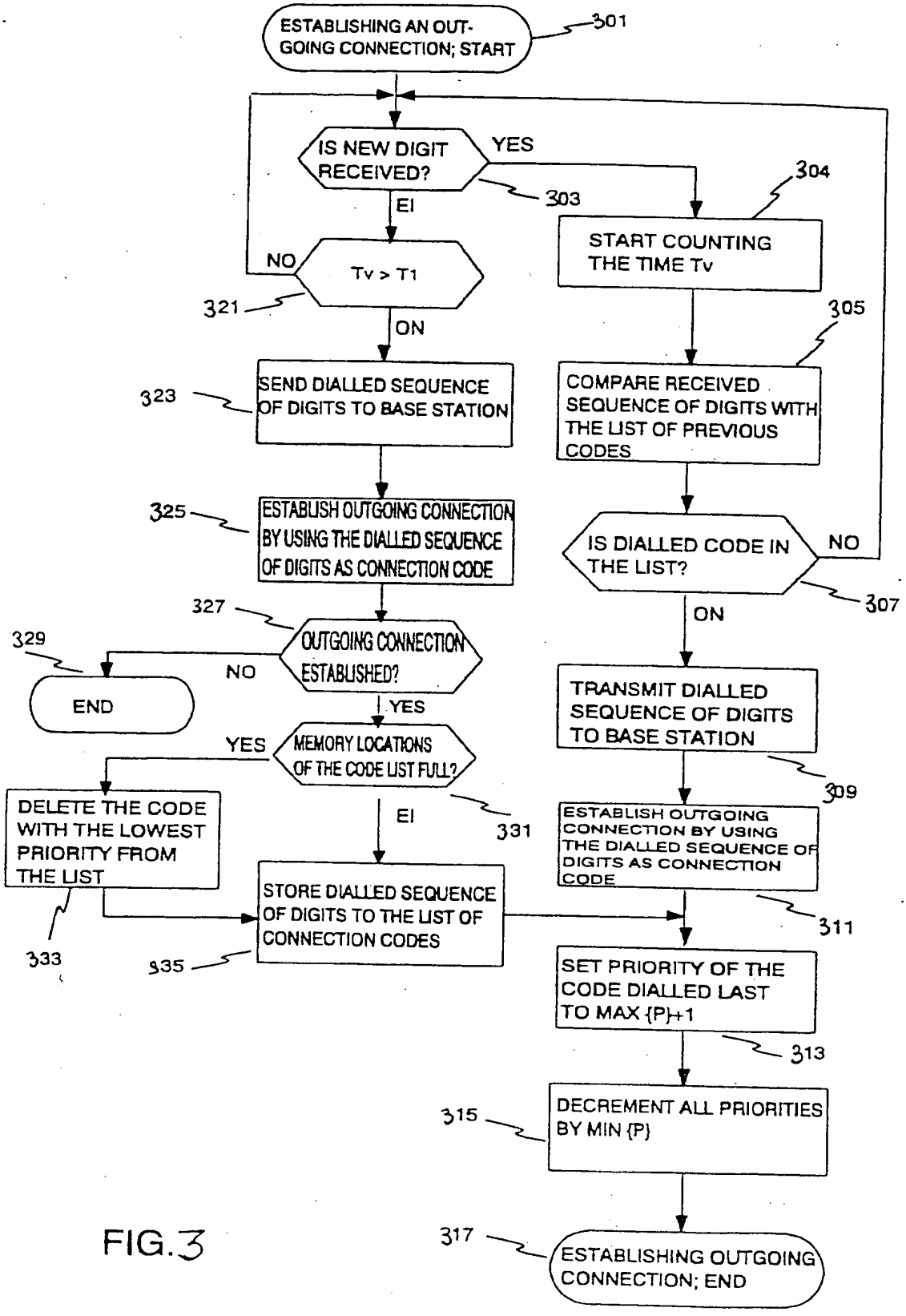
ESTABLISHING AN OUT-GOING CONNECTION; START
301
IS NEW DIGIT RECEIVED?
YES
303
304
EI
START COUNTING THE TIME Tv
NO
Tv > T1
321
ON
305
SEND DIALLED SEQUENCE OF DIGITS TO BASE STATION
323
COMPARE RECEIVED SEQUENCE OF DIGITS WITH THE LIST OF PREVIOUS CODES
ESTABLISH OUTGOING CONNECTION BY USING THE DIALLED SEQUENCE OF DIGITS AS CONNECTION CODE
325
IS DIALLED CODE IN THE LIST?
NO
307
ON
327
OUTGOING CONNECTION ESTABLISHED?
329
NO
END
YES
TRANSMIT DIALLED SEQUENCE OF DIGITS TO BASE STATION
309
YES
MEMORY LOCATIONS OF THE CODE LIST FULL?
DELETE THE CODE WITH THE LOWEST PRIORITY FROM THE LIST
EI
331
ESTABLISH OUTGOING CONNECTION BY USING THE DIALLED SEQUENCE OF DIGITS AS CONNECTION CODE
311
333
STORE DIALLED SEQUENCE OF DIGITS TO THE LIST OF CONNECTION CODES
335
SET PRIORITY OF THE CODE DIALLED LAST TO MAX {P}+1
313
DECREMENT ALL PRIORITIES BY MIN {P}
315
317
ESTABLISHING OUTGOING CONNECTION; END

FIG.3

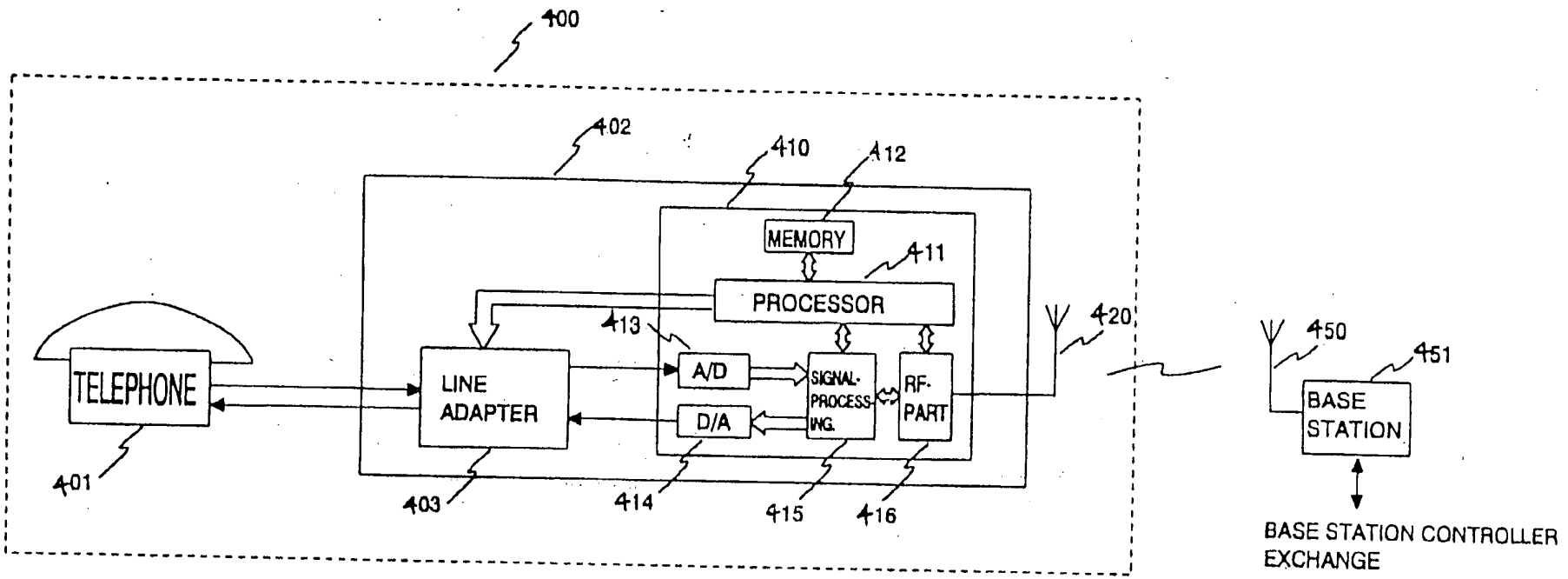
400
402
410
412
MEMORY
411
PROCESSOR
413
A/D
D/A
SIGNAL-PROCESSING
RF-PART
420
TELEPHONE
LINE ADAPTER
401
403
414
415
416
450
451
BASE STATION
BASE STATION CONTROLLER EXCHANGE

FIG. 4

2311696

Terminal Equipment

The present invention relates to telecommunications terminal equipment. In particular, it relates to terminal equipment for a Wireless Local Loop (WLL) system. Also, it relates to a method for establishing a connection in a data transmission system, and terminal equipment and a data transmission system.

WLL systems are a preferable way to extend the public switched telephone network to new subscribers since the extension can be carried out without having to provide cabling for each subscriber separately. In wireless local loop networks, that is in WLL networks, the terminal equipment which are in use comprise a telephone or some other subscriber equipment which is suitable for connecting to the public switched telephone network (PSTN) and terminal equipment connected to it.

A solution is known in which WLL terminal equipment is implemented by using a separate cellular telephone or a radio part and a line adapter which executes the adapting between the PSTN connection and the cellular telephone/radio part. The line adapter contains a microcontroller or an equivalent control logic which executes the identification of dial tone multi-frequency (DTMF) characters, their conversion into messages to be transmitted to a cellular telephone and an analysis of the termination of number dialling which is based, for example, on time-out or on a termination signal. The line adapter transmits the messages to the cellular telephone, for example, via a serial bus according to the manufacturer. Additionally, in solutions according to the prior art, the line adapter comprises a power supply for feeding the supply voltage to the cellular telephone. The transceiver unit is usually connected by radio to the cellular service, which could be, for example, to the GSM system. In this case, a mobile station can be used as a transceiver unit.

Fig. 1 shows a known solution for the implementation of WLL terminal equipment. The WLL terminal equipment 100 is connected to a cellular system which comprises base stations 151 for transferring data by radio via an antenna 150 to terminal equipment. The base stations are connected to base station controllers 152 which are further connected to a switching center 153. The switching center 153 is linked to the public switched telephone network PSTN.

Terminal equipment 102 comprises an antenna 104 for transmitting and receiving a radio frequency signal. The received signal is amplified and demodulated into a baseband signal in an RF part 113 of a transceiver 110 and the baseband signal is processed in block 114. Similarly, the transmitted baseband signal is converted into a digital form and processed for transmission in block 114 according to specifications of the cellular system and modulated into an RF frequency and amplified in the RF part 113 for transmission to the antenna 104.

The signal processing block and the RF part are controlled by a processor 111 to which a memory 112 is connected for storing programs, parameters and status mode data. A regulator 115 forms the supply voltages for the blocks of the transceiver unit 110.

A line adapter part 130 comprises an audio part 134 which executes the mutual adaptation of the audio signals of the telephone set and the transceiver. A DTMF detector 133 detects dialling signals which are transferred in the audio line and transmits them to the processor 131 of the line adapter element. A HOOK detector 135 detects the state of the hook switch of the telephone device 101 and transmits the status mode data to the processor 131 and to a tone generator 136. The tone generator 136 forms audio signals to the telephone according to the status of the connection which has been transmitted by the cellular system. A ringing generator 137 forms a high voltage ringing signal (for example, 45 V AC) for the ringing function of the telephone set. Line voltage/loop current (for example, 40 V DC) is formed of the high voltage formed by a DC/DC converter block in a DC regulator 138 to correspond to the specifications of the telephone

set. The processor 131 controls the other blocks of the line adapter and the processor 131 is connected to the processor 111 of the mobile station part 110, for example, through a serial bus. The program of the processor 131, the parameters connected to the functions of the line adapter and the status mode data of the connection are stored into a memory 132 that is connected to the processor 131.

The above presented solution according to the prior art has been described in more detail in the patent specification US 5117450 (WO 9014729).

One disadvantage of the known solutions is, for example, that the microcontroller and the related memory circuits of the line adapter increase the manufacturing costs of the device. Furthermore, the microprocessors of the line adapter and the transceiver function as completely separate devices, which can cause problems in their interaction, especially in exceptional situations. The functional reliability is reduced by the use of two separate and independent microcontrollers since microcontrollers are usually connected loosely to each other, for example, through a serial bus, which means that only some data about their status modes is transferred between them. This leads very easily to a variety of malfunctions. For example, in situations where there is some fault in the radio network, the microcontrollers may end up in mutually different operational states. For example, the microcontroller of the line adapter may interpret the connection as being on but the microcontroller of the transceiver is using the information which indicates that the connection has been switched off due to an error state in the radio network.

Turning now to the method for establishing outgoing connections, terminal equipment and data transmission system.

In data transmission systems, the outgoing connection is usually established by a connection code, such as a telephone number. In a fixed line telephone network, each digit of the number is directly transmitted to the exchange as the dialling

proceeds. The dialled numbers are analysed in the exchange, and a connection is established right after the dialled sequence has been detected to be an existing telephone number.

Typically, in cellular systems, dialling is done locally. The number is dialled on the keypad and, once the dialling has been completed, a special SEND key is pressed to transmit the dialled number information to the system for analysis.

Terminal equipment used in wireless local loop (WLL) networks include a telephone which can be linked to the public telephone network and a transceiver unit connected to it. Usually, the transceiver unit is linked to the cellular services by radio communication. However, as there is no SEND key available, one of the problems in the WLL systems has been how to decide, when the dialling has been accomplished.

A previously known solution is to use a special end character, which tells the dialling has been completed. A special key character is such a character (e.g. # or *) which is normally not used for dialling. Pressing of the special key tells the terminal that the dialling has been completed, and the number can be transmitted to the base station of the data transmission system. A disadvantage of this solution is, however, that the dialling procedure differs from the one used in conventional fixed networks, and thus the user has to master several different dialling procedures.

Another prior art solution has been to use time supervision. According to this, the elapsed time starting from the last dialled digit is counted, and after a predetermined time, the dialling is supposed to have been completed and the dialled sequence of digits is transmitted to the base station as the connection code.

However, the problem with time supervision is the considerable additional delay needed for the establishment of the connection. This delay is summarised with

the time that the system needs to establish the connection. Together, these time delays can become too long compared with the ones needed in a conventional fixed network, where the time elapsed after the dialling of the sequence of digits can be very short. This problem can be diminished by shortening the predetermined delay time. This, however, leads to other problems. Namely, the dialling procedure is not always a constantly ongoing process; e.g. a telephone catalogue may be consulted at the same time for numbers not yet dialled, which may cause a pause of several seconds. If this pause is interpreted as the completion of the dialling procedure, the terminal equipment sends an incomplete telephone number to the base station, and the establishment of the connection fails.

Prior art solutions for realization of WLL systems have more closely been described e.g. in the following patent publications: [1] US 4 658 096; [2] US 4 737 975; [3] US 4 775 997, and [4] US 4 922 517.

According to the invention, the terminal equipment is provided with a processor which controls both the baseband signal processing block and the line adapter part. Consequently, components which are included in the baseband part of the transceiver can be used for inducing line adapter functions, the number of the components and the manufacturing costs can be reduced and the functional reliability of the terminal equipment can be improved.

According to one aspect of the present invention the terminal equipment for a wireless local loop of a data transfer system comprises

- an interface for connecting a subscriber device to the terminal equipment,
- means for transmitting and receiving an RF signal according to the data transfer system,
- means for executing a conversion between said RF signal and an audio signal,
- signal processing means for processing an audio signal,
- adapter means for executing the adaptation of an audio signal between the subscriber device and the signal processing means,

- means for receiving dialling signals from a subscriber device,
- means for transmitting data which is included in the dialling signal received from the subscriber device to the data transfer system,
- means for receiving status mode data of the connection from the data transfer system,
- means for feeding a signalling signal to the subscriber device on the basis of the status mode data of the connection received from the data transfer system,
- first control means to control said signal processing means, means for transmitting data included in the dialling signal received from the subscriber device to the data transfer system and/or means for receiving status mode data of the connection from the data transfer system and
- second control means to control said adapter means, means for feeding a signalling signal to the subscriber device and/or means for receiving dialling signals from the subscriber device,

is characterized in that said first control means and second control means are substantially the same control means.

Preferable embodiments of the invention have been presented in the dependent claims.

According to another aspect of the present invention, there is provided a method which, while dialling the connection code, monitors the dialled digits of the sequence and controls, whether the sequence of digits formed by the dialled digits falls within the connection codes dialled last, and advantageously, whether an outgoing connection has previously been established by it. If the sequence of digits is the same as one of the connection codes used last, it is known that the code does not contain any more digits, and thus the dialled sequence of digits is sent to the base station of the data transmission system for connection establishment. If, instead, the dialled sequence is none of the ones dialled last, the terminal equipment waits for the dialling of the next digit for a predetermined time, and if the next digit is not dialled within this time, the terminal equipment sends the sequence of digits formed by the dialled digits to the base station for

connection establishment. The connection codes dialled last are stored in the memory of the terminal equipment so that the dialled sequence of digits can be compared with these.

In this case, a connection code is a code including the data about the destination of the outgoing connection in the data transmission system. Advantageously, the connection code is a sequence of characters consisting of numbers, letters and/or symbols, such as a telephone number.

It is characteristic for the method of the present invention that at least one connection code is stored in the terminal equipment, the dialled sequence of digits is compared with at least the one connection code stored in the terminal equipment, and that the dialled sequence of digits is sent to the base station as a connection code, in accordance with the result of the comparison made.

It is characteristic for the terminal equipment according to the present invention that it comprises means for storing at least one connection code, means for comparing the sequence of digits with at least the one stored connection code, and means for sending the dialled sequence of digits as a connection code to the data transmission system in accordance with the result of the comparison made.

It is characteristic for the data transmission system of the present invention that at least one connection code is stored in the terminal equipment related with the data transmission system, the dialled sequence of digits is compared with at least the one connection code stored in the terminal equipment, and that the dialled sequence of digits is sent as a connection code from the terminal equipment to the base station in accordance with the result of the comparison made.

Embodiments of the present invention are described, by way of example, with reference to the accompanying drawings, of which:

fig. 1 shows a block diagram of terminal equipment according to the prior art and its connection to the data transfer system,

fig. 2 shows a block diagram of terminal equipment according to an embodiment of the invention and its connection to the data transfer system;

fig. 3 is a flow diagram of a method of the present invention for establishing an outgoing connection; and

fig. 4 is a block diagram of terminal equipment according to the invention, and of the way it is connected to the data transmission system.

In the following, the invention is described as if it were connected to the GSM data transfer system although the application of the invention is in no means restricted to the above mentioned system. The GSM system has been described more closely, for example, in the standards of the GSM system which have been published by the European Telecommunication Standards Institute (ETSI) and in the publication Mouly, Pautet, The GSM System for Mobile Communications, 1992.

Fig. 2 shows terminal equipment 200 according to the invention. In it, a line adapter 202 has been implemented by means of a SLIC (Subscriber Line Interface Circuit) circuit which is generally used, for example, in office switchboards. The SLIC circuit contains, on the same chip, adapter circuits for adapting audio signals and signalling signals which correspond to the adapter functions of blocks 134, 135, 136 and 137 of the solution presented in Fig. 1.

Furthermore, a line adapter 230 comprises means for forming a high tension supply voltage to the SLIC circuit. In the WLL terminal equipment, the supply voltage of the line adapter has to be formed of low direct voltage since, to ensure the possibility of emergency operation, the line adapter has to function with batteries 203 as well. The supply voltage is formed in a DC/DC converter block

234 implemented by, for example, a chopper. The SLIC circuit forms a ringing and line voltage from a supply voltage formed by a DC/DC converter block 234. A microcontroller which is included in the baseband elements of the terminal equipment controls the output voltage of the chopper 234 via a control line according to the operating state of the terminal equipment thus minimizing current consumption and improving reliability. However, the internal power distribution of the baseband part 210 and of the RF part 240 has been optimized to be compatible with the supply voltage which is obtained from a battery or from a supply unit in which case their supply voltage need not be formed separately in the line adapter element. Thus it is possible to avoid any dissipation of power occurring in the regulator.

According to the invention, the line adapter has no control means of its own but the line adapter functions are controlled by a processor 211 which operates as a control means of the baseband part 210. Programs, parameters and status mode data of the connection are stored which are connected to the control functions of the RF part 240, the baseband part 210 and the line adapter part 230 are stored into a memory 212 that is connected the processor 211.

The input and the output audio signal are coupled directly from the signal part of the SLIC circuit to the audio block (Audio) which is included in the baseband elements. In the WLL terminal equipment which is intended to be connected to digital cellular systems, the audio block can be, for example, a separate PCM (Pulse Code Modulation) codec or a converter which has been generally used in ISDN telephones. It is to be noted that in the terminal equipment according to the invention, the line adapter need not detect dialling tones which come from the telephone or form signalling tones to the telephone since this can be done preferably in the baseband elements, as with the PCM codec or at the digital signal processor (DSP). In the case where it is a connection network which has been optimized for WLL use, the dialling tones can be detected and the signalling tones are formed only at the local switching center. Thus there is no need for a separate DTMF detector to be connected to the solutions of the prior art, instead

a signal processor can be included in the baseband elements to be used for the detection.

As was mentioned earlier, as a line adapter can be used, for example, a SLIC circuit which is manufactured for an office switchboard and which, in the solution according to the invention, is controlled preferably by the only microcontroller of the terminal equipment via the control bus of the SLIC circuit. The type of bus can be, for example, a parallel bus which contains an interrupt line or alternatively a serial bus such as I2C.

The degree of integration can still be improved from that presented above, for example, by integrating the chopper and the SLIC circuit into a circuit which operates on one low supply voltage and in which necessary higher voltages are formed internally. Furthermore, the baseband elements could be integrated to one circuit. On the other hand, since the line adapter has to deal with relatively high voltages, for example, 70 V, it is preferable that it should be implemented as a distinct circuit on its own, being separated from other baseband elements with low voltages.

For other parts than those which have been described earlier, the functions and the implementation of the terminal equipment according to Fig. 2 correspond to the functions of the terminal equipment shown in Fig. 1.

By means of the arrangement according to this aspect of the invention, numerous advantages can be achieved compared to the solutions according to the prior art. The number of components in the terminal equipment can be reduced, which makes it possible to reduce the manufacturing costs of the terminal equipment. When one microcontroller is used in the terminal equipment, also the operational reliability of the terminal equipment can be considerably improved. On one hand, the reduction in the number of complicated circuits reduces the risk of failure of the circuits and on the other hand, failure situations due to the presence of many microcontrollers are avoided altogether.

In Fig. 3, there is shown a method according to the invention for establishing an outgoing connection. Upon establishment of an outgoing connection, 301, the digits of the sequence of digits being dialled are monitored in block 303, and after the selection of a new digit, the time Tv elapsing from the dialling of the last digit is counted in block 304. Thereafter, the dialled sequence of digits is compared with the stored connection codes, blocks 305 and 307. If the dialled sequence is not found among the stored codes, block 303 is consulted again. If the dialled sequence of digits is included in the list of the stored codes, the dialled sequence of digits is sent as a connection code to the base station, block 309, and the system establishes an outgoing connection on the basis of the connection code transmitted to the base station.

Priority data, according to which the connection codes are deleted from the list when all memory locations are full, is connected to the connection codes to be stored. The priority data related with the connection codes advantageously discloses, in which order the connection codes have been used previously. Also other factors can affect the priority; e.g. number of the times the connection code has been used. The priority data is next considered as a numerical value, although, in practice, it can also adopt another form, such as location of the connection code in the memory.

A priority value, which is the highest of the priorities related with the stored connection codes, is advantageously connected to the code dialled last. The priority Pv of the selected code is thus set, for example, to a value, which is the maximum priority Pmax of the connection codes stored previously, added with one, i.e. Pv = MAX {P} + 1, block 313. In order to prevent the absolute values of the priorities from growing higher than is necessary, all the priority values are thereafter decremented by the value MIN{P}, which is the lowest of all the priority values, block 315. Thus the connection code with the lowest priority is set to the priority value zero.

If in the block 303 it is detected that a new digit has not been dialled, it is checked, whether the time elapsed from the dialling of the last digit, Tv, is longer than the predetermined first delay T1, block 321. If Tv is not longer than T1, block 303 is consulted again. If the time elapsed from the dialling of the last digit, Tv, is longer than the predetermined delay T1, the selected sequence of digits is used as the connection code for the outgoing connection. Then the selected sequence of digits is transmitted as the connection code to the base station, block 323, and the system tries to establish the outgoing connection on the basis of the connection code transmitted to the base station, block 325.

Thereafter it is monitored, whether the connection establishment is successful, block 327. If the establishment of the connection fails, measures for setting up a connection on the basis of the dialled sequence of digits are ended, block 329. The dialled sequence of digits is then not stored in the connection code list. The reason for the failure of the connection establishment may namely be, for example, that last digits are missing from the dialled sequence; storing the sequence of digits in the list might also later cause the incomplete sequence of digits to be transmitted to the base station, although the sequence of digits were dialled in complete form.

The establishment of an outgoing connection can be checked e.g. on the basis of a message the system transmits to the terminal equipment. For example, in the GSM system, the network sends a special "CONNECT" message for the terminal equipment, meaning that the other party has answered. The CONNECT message includes e.g. data about the connection code to which the connection has been established. Thereafter, the terminal equipment answers the network with "CONNECT ACKNOWLEDGEMENT" message and begins the data transmission connection of the user. The signalling for establishing an outgoing connection in accordance with the GSM system has been described more closely in the publication European Telecommunication Standards Institute (ETSI) prETS 300557, 05/1995, GSM 04.08 version 4.11.0.

In analog systems, such as in the NMT system, a message indicating the succeeding of the connection establishment and the validity of the used connection code can be indicated in the terminal equipment, for example, by monitoring the "ringing" or the "busy" tone received from the network. Besides the succeeding of the connection set-up, also other network information can be used to indicate whether the sequence of digits transmitted to the base station is an existing, complete connection code.

In case there were an incomplete connection code among the stored codes, it may be advantageous to wait another time delay T2 in block 309 before the dialled sequence of digits is sent to the base station; during the time delay the user may dial the next digit, returning thus to block 304. Thus it is possible to avoid the transmission of a stored, incomplete connection code to the base station. The said time delay T2 is, however, shorter than the time delay T1.

If, in the method described in Fig. 1, the connection is successfully established in block 325, the system checks if all the memory locations are full, block 331. In case all memory locations are full, the connection code with the lowest priority is deleted from the list, block 333. Next the dialled sequence of digits is stored in the list of dialled connection codes, block 335. Finally, the priorities of the stored connection codes are set, as described above, blocks 313 and 315, whereafter the establishment steps for an outgoing connection are completed, 317.

The memory, in which the list of the dialled connection codes are stored, can be organized e.g. according to the following table:

	Connection code 1	Priority	value
P(1)=0			
	Connection code 2	Priority	value
P(2)=1			
	Connection code 3	Priority	value
P(3)=2			

----	----	
----	----	
Connection code N	Priority	value

P(N)=N-1

If the connection code N+1 dialled next is not found in the list of the connection codes stored previously, it is stored in place of a connection code with the lowest priority in the list, i.e. in the above-mentioned example in place of the connection code 1. The new stored connection code is given a priority value which is higher than any priority value of a previously stored connection code, for example N. After this, the connection code 2 has the lowest priority value, the value being 1. In order to prevent the absolute values of the priorities from increasing upon storing new priority values in the table, the lowest priority value of all the priorities in the list is decremented, i.e. value one in the example. Thereafter, the table is as follows:

Connection code N+1	Priority	value

P(N+1)=N-1

Connection code 2	Priority	value

P(2)=0

Connection code 3	Priority	value

P(3)=1

----	----	
----	----	
Connection code N	Priority	value

P(N)=N-2

The priority values presented above have been shown as an example for illustrating the processing of the stored connection codes. In practice, it is not necessary to store the priority values separately for each connection code, but the priority information related with the connection codes may advantageously be indicated on the basis of the memory location. Then it is possible to store the connection codes to the memory locations e.g. in a predetermined order; in this case, one has to retain the information about which memory location contains the

connection code stored last. The priorities of the other memory locations are determined by the said storing order.

One of the connection codes stored in the memory can be the emergency call number. It can be stored in a special memory location the contents of which can be altered only by a special command. Because the emergency call number is thus not replaced by the new selected connection code, no priority value is needed for it. Besides the emergency call number, also other special connection codes can be stored in the list, that are not deleted from the memory on the basis of priority information.

Fig. 2 is a block diagram of a WLL terminal device 400 according to the present invention and of its connection to the data transmission system. It comprises an ordinary telephone adaptable to a subscriber connection of a conventional public telephone network that is connected with a radio component 410 via a line adapter 403. The radio component 410 may advantageously be a mobile station. The terminal equipment is connected to the base station 451 of the data transmission system by radio communication. For this purpose, the radio component and the base station have the antennas 420 and 450. The base station is still connected e.g. to the base station controller and the exchange of the data transmission system.

In case of a digital radio interface, an analog signal received from the telephone is converted to a digital signal using an A/D converter 413, the digital signal is given a signal processed 415 as determined by the data transmission system, and a transmission signal on a radio frequency is modulated with the produced signal in RF component 416, the modulated transmission signal being fed forward to the antenna 420.

Similarly, the signal received on a radio frequency is received from the antenna 420 to the RF component 416, where the signal is demodulated. The digital signal received from the RF component is given a signal processing, 415, and

this digital audio signal is converted to an analog signal using a D/A converter 414.

In case the radio interface is based on analog FM modulation, the components 413-416 are replaced correspondingly by FM modulator in signal transmission and FM demodulator in signal reception.

A telephone for a conventional telephone network uses high voltages even of 60V between the telephone and the exchange. Also the call function of such a telephone is based on the voltage control in the operation loop. In order to establish such a connection, a line adapter is needed for connecting the conventional telephone and its accessories to a wireless subscriber connection. The line adapter produces a line voltage and indicates when the handset is on/off hook. In addition, the formation of dialling signals (and other control signals) is also carried out in the line adapter. Further, the line adapter can perform the indication of DTMF signals. The line adapter is realizable by using known circuits, such as SLIC (Subscriber Line Interface Circuit). One such SLIC suitable for this purpose is the type Am79R79 manufactured by the company Advanced Micro Devices (USA). The interface between the telephone and the line adapter comprises typically 2 - 4 conductors.

The maximum voltage between the amplitude levels and the A/D (or D/A) converter is typically 3V or 5V. The same maximum voltage level is typically used also between the line adapter and the FM modulator as well as the line adapter and the FM demodulator.

The operation of the line adapter is typically controlled by a microprocessor. The microprocessor may advantageously be a processor 411 of a mobile station 410, or it may be a separate processor. The mobile station process 411 may advantageously be used also for counting the time elapsed from the dialling of the last digit and for comparing the dialled sequence of digits with stored,

previously dialled connection codes. Also a memory 412 connected to the processor 411 may be used for storing the previously dialled connection codes.

The mobile station 402 may also include other blocks, such as operation interface equipment, which are not shown in the drawings.

Some embodiments of the solution according to the invention have been presented above. Naturally the principle according to the invention can be modified within the frame of the scope of the claims, for example, by modification of the details of the implementation and ranges of use.

Claims

1. Terminal equipment for a wireless local loop of a data transfer system wherein the terminal equipment comprises

- an interface for connecting a subscriber device to the terminal equipment,

- means for transmitting and receiving an RF signal according to the data transfer system,

- means for the implementation of conversion between said RF signal and an audio signal,

- signal processing means for processing the audio signal,

- adapter means for adapting the audio signal between the subscriber device and the signal processing means,

- means for receiving dialling signals from the subscriber device,

- means for transmitting data which is included in the dialling signal received from the subscriber device to the data transfer system,

- means for receiving status data of the connection from the data transfer system,

- means for feeding a signalling signal to the subscriber device on the basis of the status data of the connection received from the data transfer system,

- first control means to control said signal processing means, means for transmitting data which is included in the dialling signal received from the subscriber device to the data transfer system and/or means for receiving the status mode data of the connection from the data transfer system and

- second control means to control said adapter means, means for feeding the signalling signal to the subscriber device and/or means for receiving dialling signals from the subscriber device,

wherein said first control means and second control means are the same control means.

2. Terminal equipment according to claim 1, wherein said control means is a processor.

3. Terminal equipment according to any of the previous claims, wherein said signal processing means function as means for forming signalling tones.

4. Terminal equipment according to any of the previous claims, wherein said signal processing means comprise means for detecting DTMF dialling tones.

5. Terminal equipment according to any of the previous claims, further comprising means for transmitting DTMF dialling tones and receiving signalling tones of the switching center in an audio channel.

6. Terminal equipment according to any of the previous claims, further comprising means for forming a common supply voltage for a line adapter block, a baseband block and for an RF part.

7. Use of terminal equipment according to any of the previous claims in the GSM system.

8. A terminal for a wireless local loop, the terminal comprising:

a radio transceiver having control means; and

means for providing an interface between the radio transceiver and a subscriber line;

wherein:

the radio transceiver control means also controls the interface.

9. A terminal for a wireless local loop, the terminal comprising:

a radio transceiver;

means for providing an interface between the radio transceiver and a subscriber line; and

a single controller for controlling both the radio transceiver and the interface.

10. A terminal for a wireless local loop substantially as hereinbefore described with reference to and/or as illustrated in Figure 2 or 4 of the accompanying drawings.

11. A method for establishing an outgoing connection from terminal equipment to a data transmission system, in which a sequence of digits is dialled using the terminal equipment, the connection code formed by the dialled sequence of digits is transmitted from the terminal equipment to the base station of the data transmission system, and the data transmission connection is established on the basis of the transmitted connection code; wherein at least one connection code is stored in the terminal equipment, the dialled sequence of digits is compared with at least the one sequence of digits stored in the terminal equipment, and the dialled sequence of digits is transmitted as connection code to the base station in accordance with the result of the said comparison.

12. A method according to claim 11, wherein when the dialled sequence of digits differs from all the connection codes stored in the terminal equipment, the system waits for the dialling of the next digit, and unless a new digit is dialled within the first time delay (T1), the sequence of digits is transmitted to the base station as the connection code.

13. A method according to claim 12, wherein the sequence of digits to be transmitted to the base station is stored in the terminal equipment as the connection code.

14. A method according to claim 13, wherein the sequence of digits to be transmitted to the base station is stored in the terminal equipment as a connection code in accordance with the establishment of the outgoing connection.

15. A method according to one of the claims 12 to 14, wherein in case the dialled sequence of digits is identical with one of the connection codes stored in

the memory, the connection code in question is transmitted to the base station before the said first time delay (T1) is up.

16. A method according to one of the claims 11 to 15, wherein priority information is connected to the stored connection codes.

17. A method according to claim 16, wherein the said priority information indicates the chronological storing order of the connection codes.

18. A method according to claims 16 or 17, wherein upon storing the connection code dialled last, a previously stored connection code is deleted from the said list, and the said connection code to be deleted is selected on the basis of the priority information related with the said connection code.

19. A method according to claim 18, wherein at least one special connection code is stored in the said list, which is not deleted from the list upon storing the connection code dialled last.

20. A terminal equipment, comprising means for dialling a sequence of digits and means for transmitting the dialled sequence of digits as a connection code to the data transmission system in order to establish an outgoing connection on the basis of the said connection code, wherein the terminal equipment comprises means for storing at least one connection code, means for comparing the dialled sequence of digits with at least the one stored connection code, and means for transmitting the selected connection code to the data transmission system in accordance with the result of said comparison.

21. A terminal equipment according to claim 20, wherein it comprises means for connecting priority information to the connection code to be stored.

22. A terminal equipment according to claim 21, wherein it comprises means for deleting the connection code from the said list in accordance with the priority information related with the stored connection codes.

23. A data transmission system including at least one terminal equipment and comprising at least one base station, the connection going out from the terminal equipment being established on the basis of a connection code, when the connection code is selected in the terminal equipment, and the selected connection code is transmitted from the terminal equipment to the base station, wherein at least one connection code is stored in the terminal equipment of the data transmission system, the dialled sequence of digits is compared with at leas the one connection code stored in the terminal equipment, and the selected sequence of digits is transmitted as connection code from the terminal equipment to the base station in accordance with the result of the said comparison.

24. The use of the method according to one of the claims 11 to 19, the terminal equipment according to one of the claims 20 to 22, or the data transmission system according to claim 22 in a WLL system.

25. A method for establishing an outgoing connection from terminal equipment to a data transmission system substantially as hereinbefore described with reference to and/or as illustrated in Figure 3 of the accompanying drawings, with or without reference to Figure 2 or 4.

The Patent Office

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Application No:	GB 9705313.6	**Examiner:**	Gareth Griffiths
Claims searched:	1-10	**Date of search:**	13 May 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4L (LECSX, LECX, LDJ)

Int Cl (Ed.6): H04B 1/40, 7/26, H04Q 7/20, 7/26, 7/30, 7/32

Other: Online Database: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB2253119 A	(MERCURY) see figs 2 & 4	8, 9 at least
X,P	WO96/24225 A1	(QUALCOMM) see fig.3 and p.8 - 13	8, 9 at least
X	US4890315	(BENDIXEN) see fig.1 and col.4 line 32 - col.5 line 35	8, 9 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

The Patent Office

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Application No:	GB 9705313.6	**Examiner:**	Gareth Griffiths
Claims searched:	11-24	**Date of search:**	19 August 1997

Patents Act 1977
Further Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4K (KBNJ), H4L (LDJ, LECC, LECX)

Int Cl (Ed.6): H04M 1/274, H04Q 7/20, 7/26, 7/32

Other: Online Database: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB2282732 A (MOTOROLA) p.21 lines 5 - 35	11, 20 & 23 at least
X	GB2252696 A (MATSUSHITA) p.5 line 25 - p.10 line 14	11, 20 & 23 at least
X	WPI Abstract Accession No. 85-270525/44 & DE3412590 A (STANDARD ELEK) 24.01.85 (see abstract)	11, 20 & 23 at least
X, P	WPI Abstract Accession No. 97-219543/20 & J09064957 A (NIPPON TELEGRAPH & TELEPHONE) 07.03.97 (see abstract)	11, 20 & 23 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.